Richardsville Elementary
The First Net Zero Energy Public School in the U.S.

Presented to:

ARMY Net Zero Energy Installations Conference

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Richardsville Elementary

- Owner – Warren County Schools
- Architect – Sherman-Carter-Barnhart
- Engineer – CMTA
- 72,285 square feet, 550 Students
- Construction Costs
  - Building $12,160,000
  - Solar Package $2,767,000
- Total Cost/SF - $206.50

Richardsville Elementary

2011 AS&U's
Special Citation –
This is an exceptional demonstration of a net-zero school—they have delivered on this commitment.
It simply puts to rest the statement 'It can't be done.'"*—2011 jury*

Richardsville Elementary Renewable Energy

208 kW thin film

138 kW crystalline

Energy Reduction
Design Focus for Net Zero

- Drastic energy reduction: Goal was 17 kBtu/sf yr
- Build on past energy successes
- Integrate new energy efficiency technologies
- Affect behavior change
- Supplement with renewable energy

ALLIANCE TO SAVE ENERGY
Creating an Energy-Efficient World

Alliance To Save Energy's - 2009 Andromeda Award

Warren County Schools' History

- Leadership in energy conservation
- Since 2003, their energy program has saved $5.9 million
- Pioneering new ideas to pursue energy savings
- Implements operations plan to further energy savings
- Life cycle analysis of systems and finishes

WARREN COUNTY PUBLIC SCHOOLS
WHERE CHILDREN PREPARE FOR SUCCESS

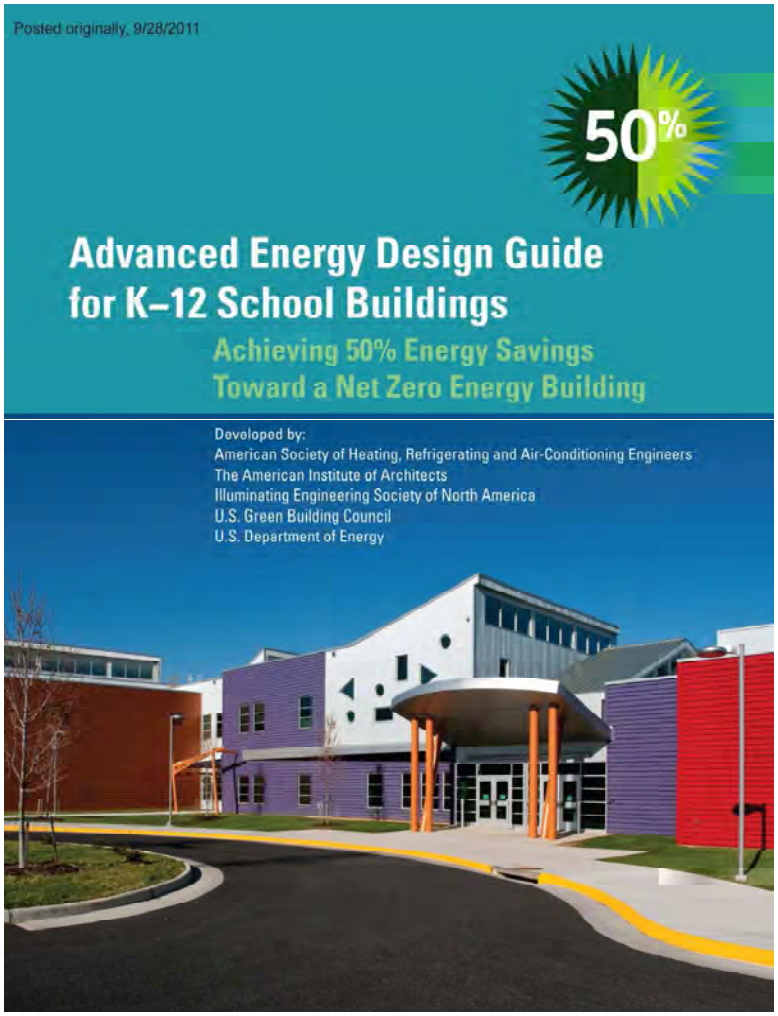
Energy is the 2nd highest cost for school districts besides personnel salaries

Leading The Way…

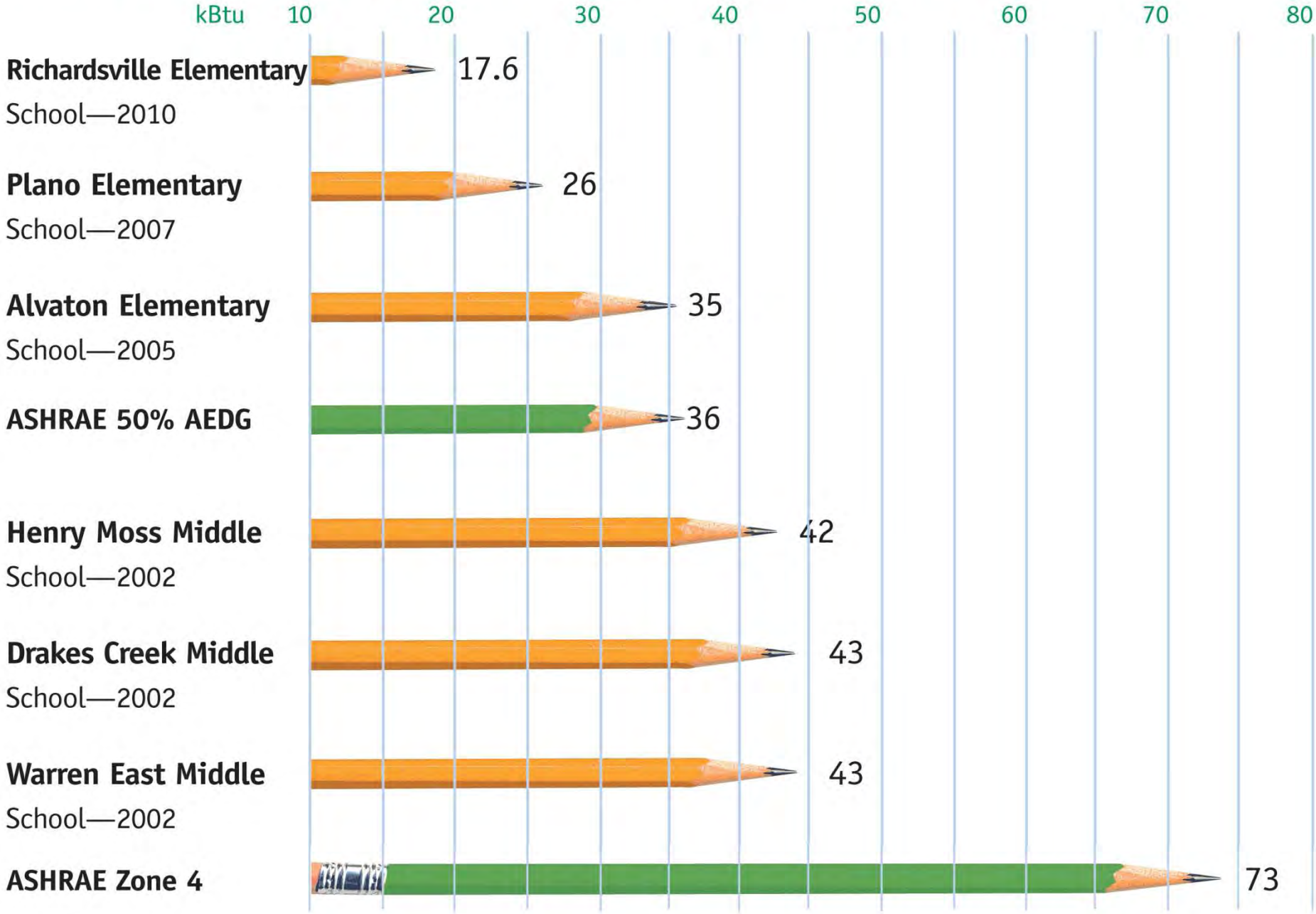
- 21 schools in the district
- 14 ENERGY STAR schools
- Most energy efficient school in the state
- First net zero energy public school in the nation
- First ICF school in Kentucky
- Largest ICF facility in North America

Energy Benchmarking Reference

- **Climate Zone 4**
  - **ASHRAE 90.1 - 73 kBtu/sf yr**
  - **50% AEDG - 36 kBtu/sf yr**

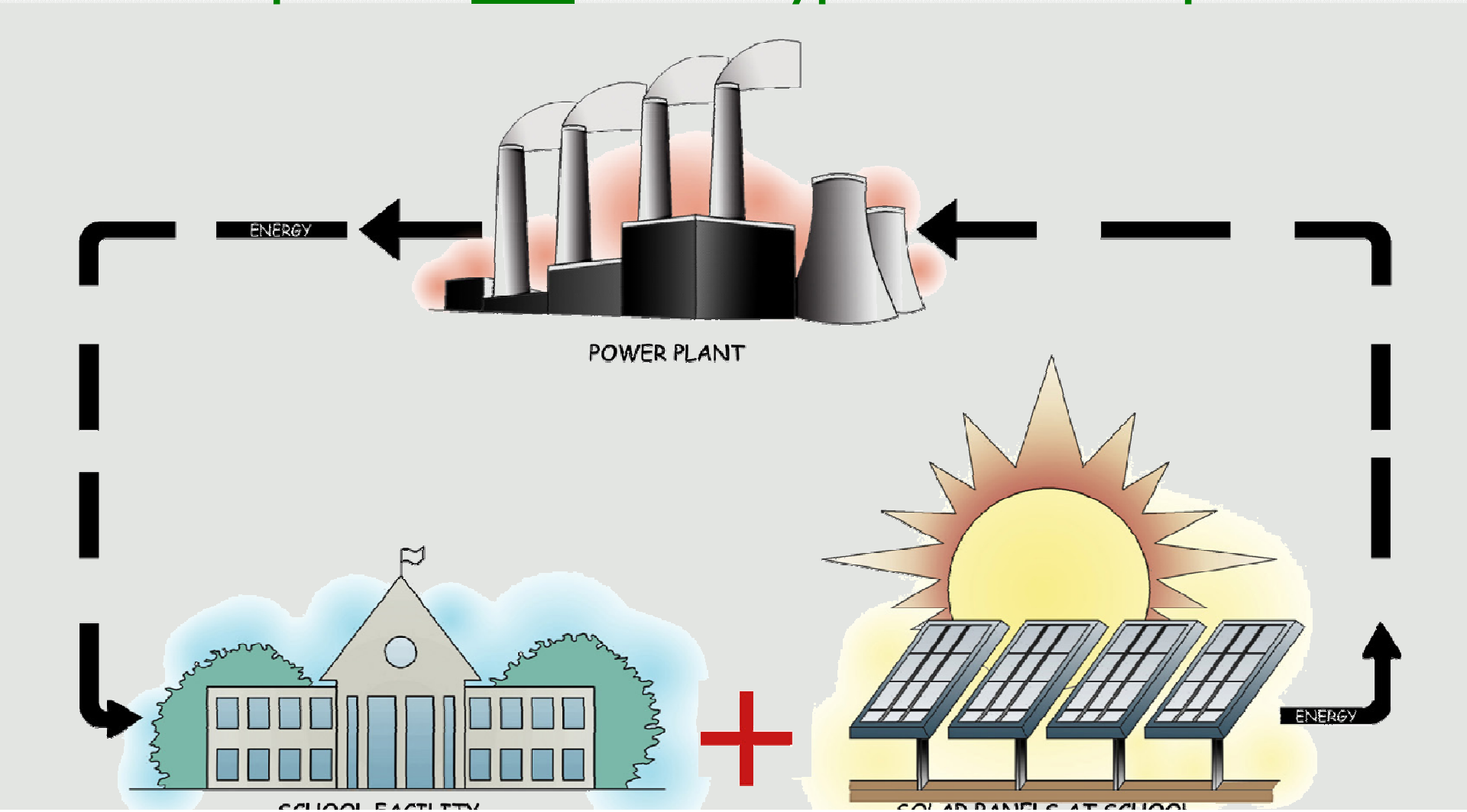


Warren County Schools Benchmarking



The Challenge: Net Zero Energy

A Net Zero Energy Building Has A Net Site Energy Consumption Of Zero Over A Typical Year Of Operation.

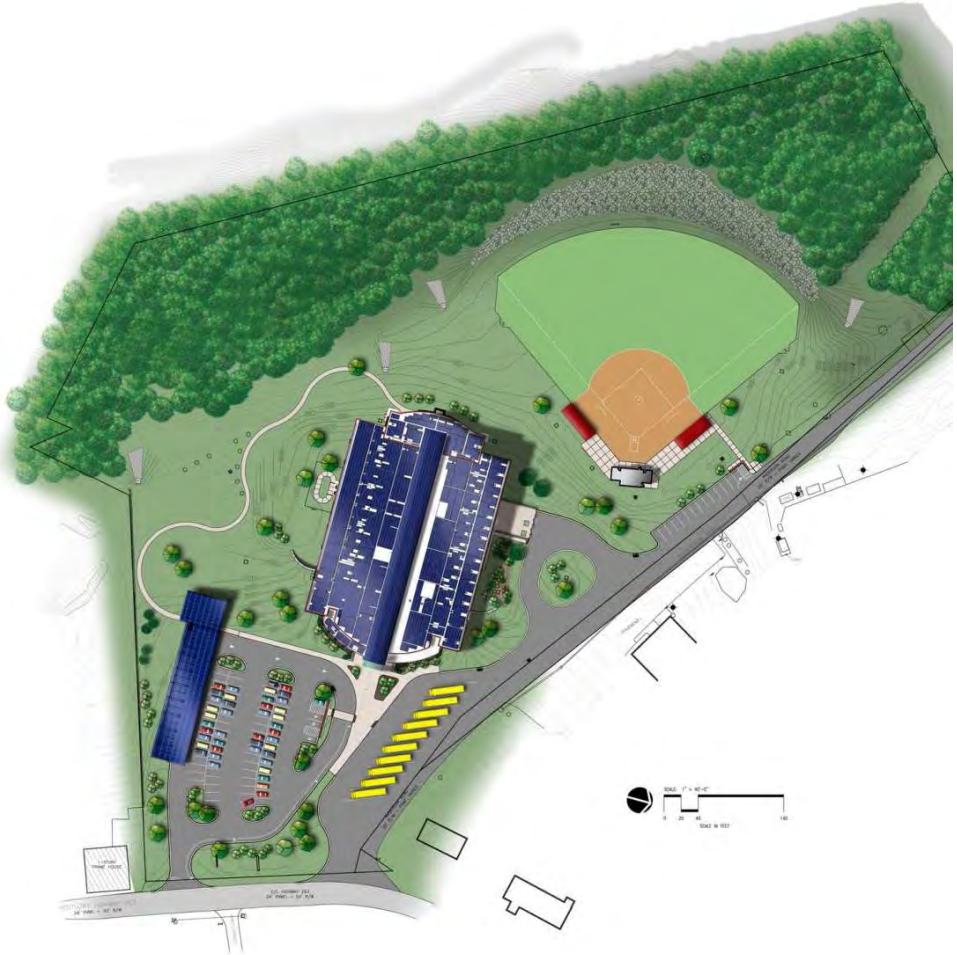


The Solution: Richardsville Elementary

- Site design and building orientation
- High performance thermal envelope
- Daylight harvesting
- Geothermal HVAC
- Behavior changes
  - Healthy kitchen
  - Information technology
  - Night lighting
- Renewable energy

Site Design & Building Orientation

- North/south building orientation
  - Provides active daylighting in academic and community spaces
- Permeable pavers /bio-swales
  - Reduce & filter stormwater run off
- Reduce/eliminate detention basins
- Native, drought resistant landscaping



High Performance Thermal Envelope

- Compact building volume reduces areas of exposed exterior surfaces
- Super insulated exterior wall and roof systems
- Reduce external air infiltration
- Reduce or eliminate large mechanical platforms

Schofield Barracks

Fort Benning Welcome Center

Vidor Government Center

Compact in Volume and Size

Lower Level

Entry Level

Daylighting Concepts

- All south classroom daylighting versus south/north building design
- Don’t over-daylight rooms, “right-size” daylighting design
- Balance lighting energy savings versus thermal envelope

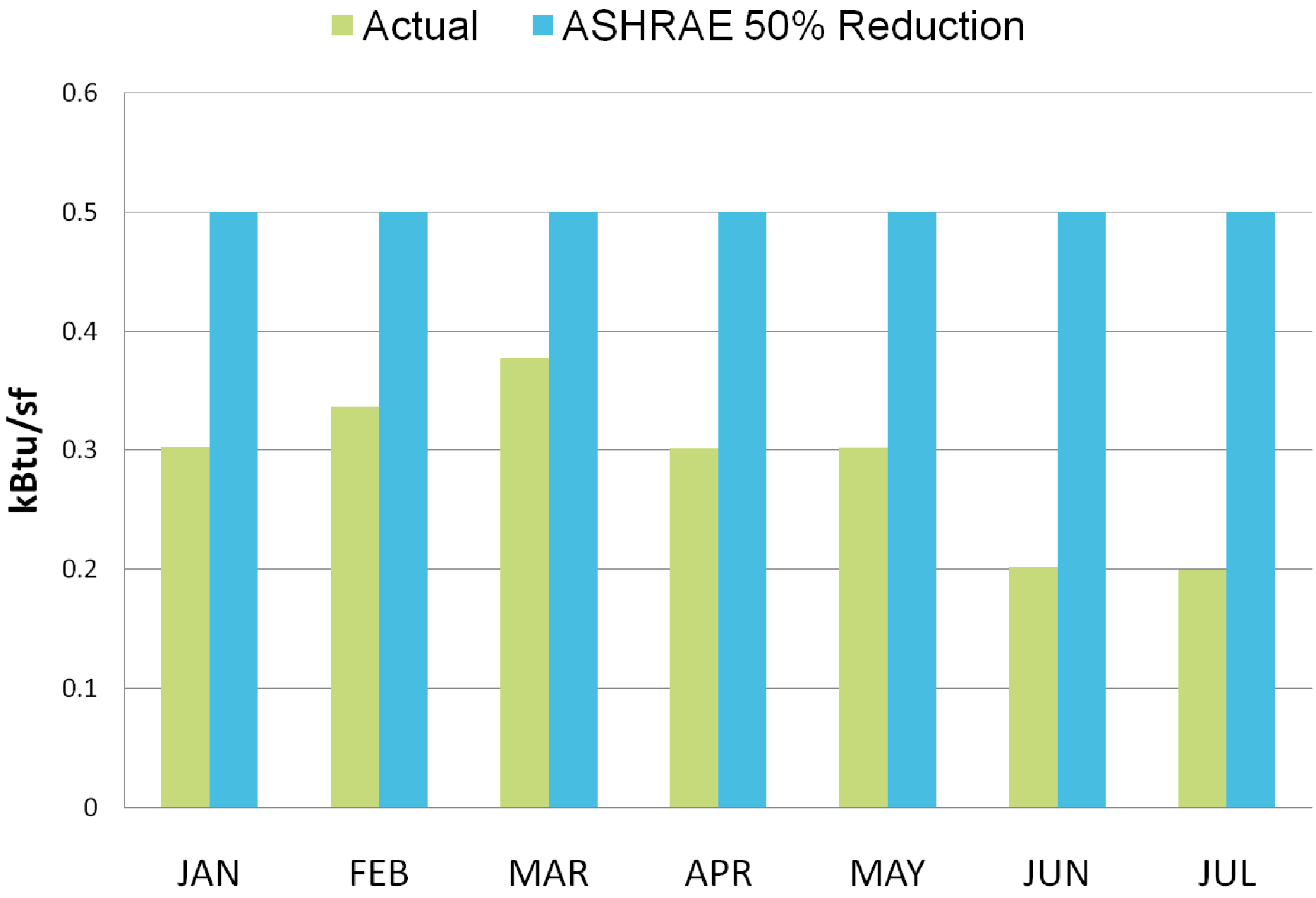
South Classroom Daylighting

- Daylight glass (20’ X 2’) with interior light shelf
- View glass has exterior shade shelf
- Two supplemental tubular daylighting devices
- 0.75 watts/SF artificial lighting with digital control system

North Classroom Daylighting

- View glass (5’ X 5’)
- Four tubular supplemental daylighting devices
- 0.75 watt/SF artificial lighting with digital control system

Lighting - Monthly



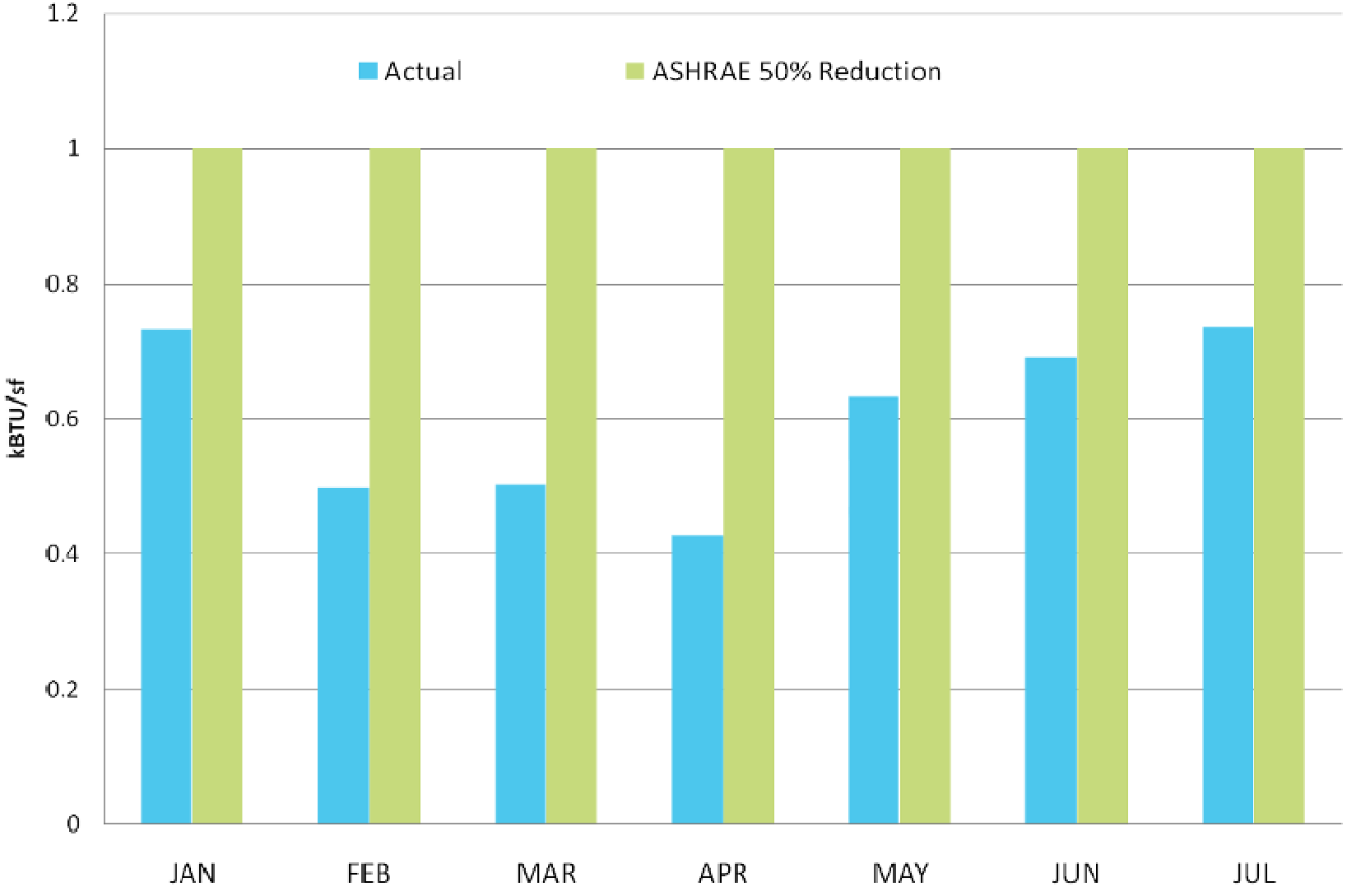
Geothermal HVAC System

- Priority part load efficiency
- Distributive pumping – minimize for energy
- One heat pump per two classrooms
- ECM motors reduce fan energy

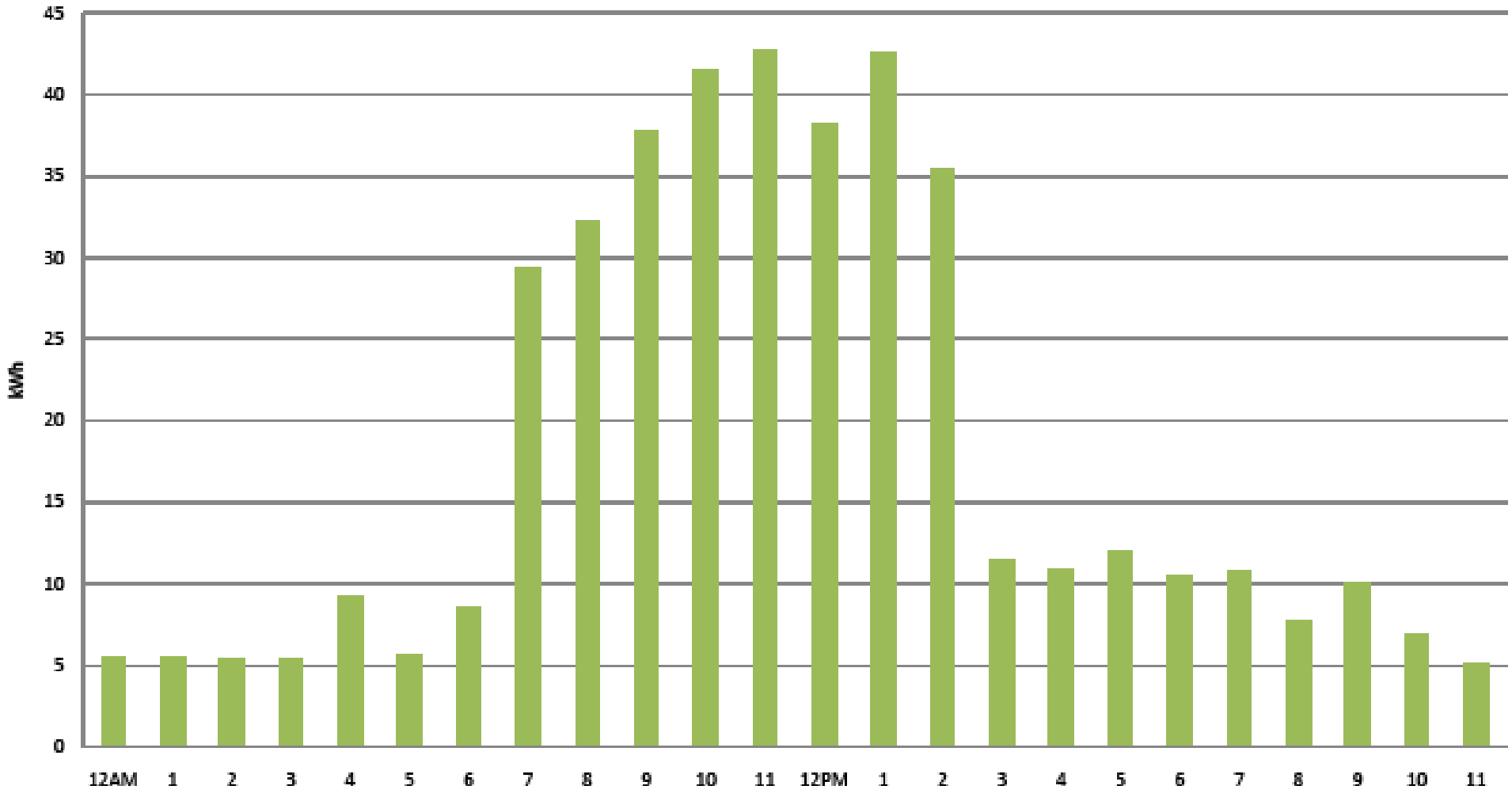
Outside Air Ventilation

- Dedicated outside air systems (DOAS)
- Heat recovery wheel
- Demand control ventilation based on CO_2 and occupancy
- Occupant diversity

Richardsville HVAC – Monthly



Richardsville Elementary HVAC Energy



Behavior Changes

- Food preparation process
- Building computer usage
- Outdoor lighting
- State regulatory agencies

Behavior Changes
Healthy Kitchen

Healthy Kitchen Design

- Test kitchen evaluation and recommendations
- ENERGY STAR appliances
- Eliminate type I hood – type II hoods

Energy Free Lunches

ED EFFICIENCIES

ENERGY TAKES A LUNCH BREAK

Warren County's energy-free lunches promote fun and responsibility

By Jennifer Wordlaw
Staff Writer

Sam Dorris, who will be a second-grader at Natcher Elementary in Warren County, spent a happy lunch period toward the end of this past school year spelling out his name with a bag of Scooby's Cheese crackers while munching through the rest of his lunch.

He and his classmates were enjoying the novelty of eating a bag lunch in the cafeteria instead of the usual hot plate lunch on a tray. And the fact that this lunch was saving energy?

"I like that, too," he said.

Elementary schools in Warren County held five "energy-free lunch" days this spring, which had the cafeteria shutting down ovens and fryers, turning off heat lamps and unplugging other kitchen equipment at minimal levels.

"We found that 22 percent of the energy in our schools was being consumed by the kitchens," said Food Services Manager Gina Howard, who said the district made the discovery as it planned and built Bowling Green's, the nation's first public school built to be net-zero energy, completed last year.

Howard said the idea for energy-free lunches came from an article in the School Nutrition Journal, and students and staff have eaten it up.

"It actually is less easier (to make) than a regular menu," said Hays Elementary Cafeteria Manager Sadie Hale.

"Now that (using the sandwiches, everything else is less time consuming. It's easier and the kids have more fun. It's like a picnic both for them."

Instead of picking up a tray when they go through the lunch line, students get a brown paper bag and fill it with a sandwich, fresh fruits and vegetables, cracker packs or even a salad in a bag that has proven widely popular with students.

"Salad is one of the harder things to get kids to eat," Howard said. "The last time we did this, we sold 200 salads in a bag. It's presented to them in a different way and students like that. They just open it, pour in their dressing and eat it out of the bag."

School board Chairman Mike Wilson said the program has been successful on several levels.

"Students know why we're doing this," he says. "They understand the necessity behind not having the kitchen all fired up that day. And this is also a new way to engage in nutrition. You may not like one item, but if it's presented to you in a different way or in a different setting, you may try something you previously thought you didn't like and find out you do like it. It broadens students' horizons."

Natcher Elementary fourth grader Mekki Mussawa said there are several things she likes about the energy-free lunches.

"I like the energy savings," she said. "I like how they put out the carrots (in little bags) because carrots are really good. It's more fun to eat this way and you don't have to do trays."

Above, students at Natcher Elementary fill their brown bags as part of an energy-free lunch day.

Right, Hays Elementary student Elijah Burchfield, rolling on days during lunch. Students say the fresh fruits and vegetables are one their favorite parts of the energy-free lunches.

Sy Wilson, Warren County's energy manager, said the energy savings from these few days can't be determined, yet efforts like these are still important.

"Definitely, it is important for our food services to serve such meals for the nutritional-educational benefits," he said. "It also displays the overall support from Mrs. Howard and her food service personnel for the district's ever-evolving energy conservation program."

Board member Mike Wilson said being energy conscious is just good policy for school boards.

"You build a building one time, but you heat it, cool it, and equip it every day for the next 40 or 50 years," Wilson said. "Seven or eight years ago when we entered into our energy-education program, we wanted to be good stewards for the taxpayers' dollars and be as efficient as possible. Every dollar we save in energy costs goes back into teachers, salaries, textbooks, and other areas that directly impact students' learning." ■

DARK IS THE NEW GREEN

At Warren Venture Independent Schools, good is not only the color of money and conservation, but is also becoming the color of safety. By turning off the lights at night, the district is both turning in savings and increasing safety.

"All the electric lights, from the classroom to the parking lot, are on motion sensors at night.

"When police come by doing their patrol, and they see lights on in the building they know that there's a problem because it shouldn't be dark," said Superintendent Bill Boyd.

The district has had a dark campus since 2008.

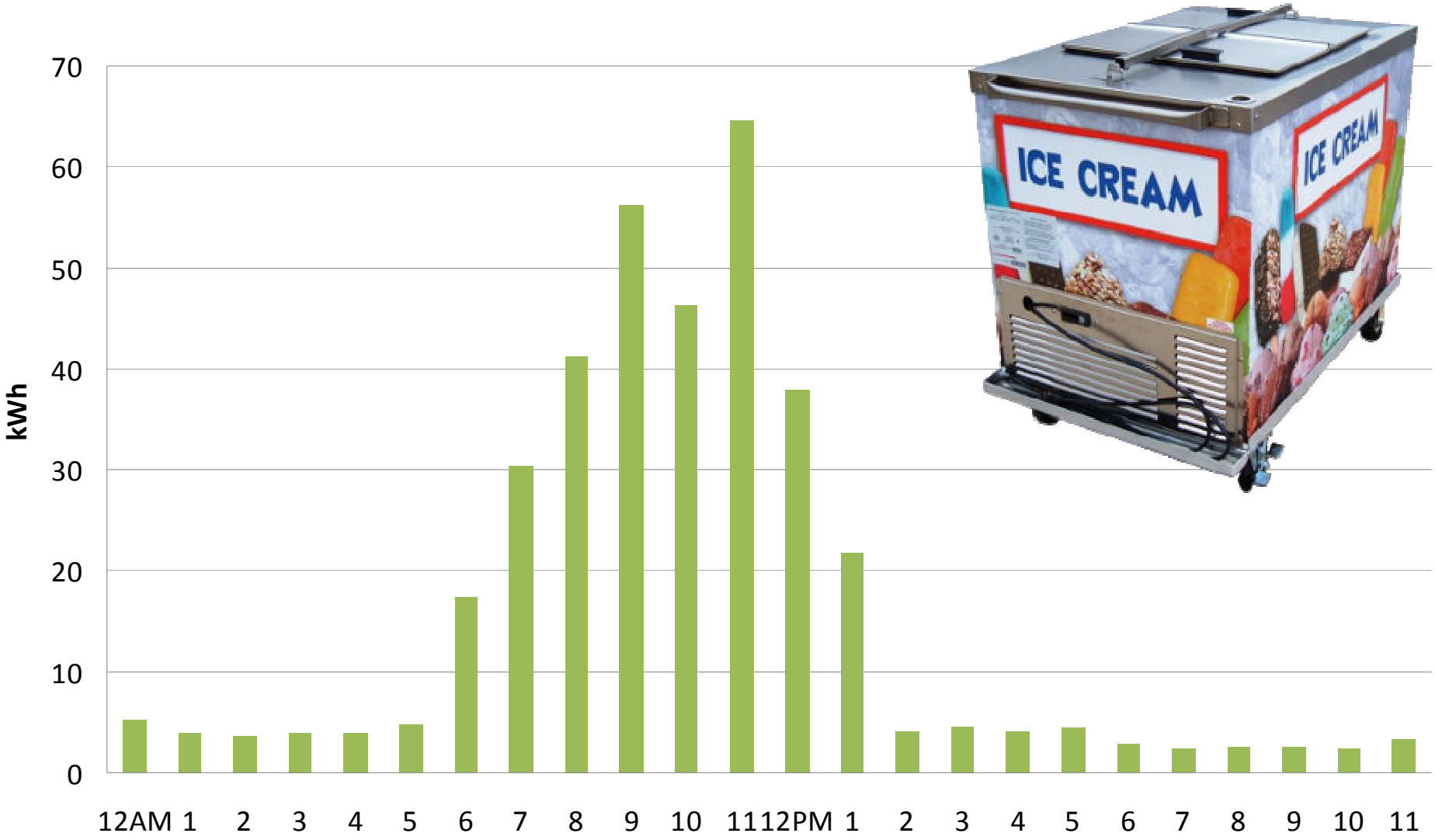
"We wanted to do it years ago, but back then, building codes required a certain amount of light in buildings at night," he said. "That's changed. The building codes have caught up with energy savings. We can now have all light off in the building when it's closed, except for the one by an camera. So we get out of our building a dark. When someone walks into our building, it improves motion sensor."

Cost savings goes for parking lots, making it easy for police and others to see anyone who shouldn't be there at night.

Boyd said because Warren Venture is a grants district, trying to determine the savings from this is tantamount to a moving target. But he said the change has been effective.

"We've gone the opposite way in terms of the old prevailing wisdom that said the more light the better and we haven't had any incidents so far. We don't want the lights on for the criminals to be able to see what they are doing," Boyd said. "Anything."

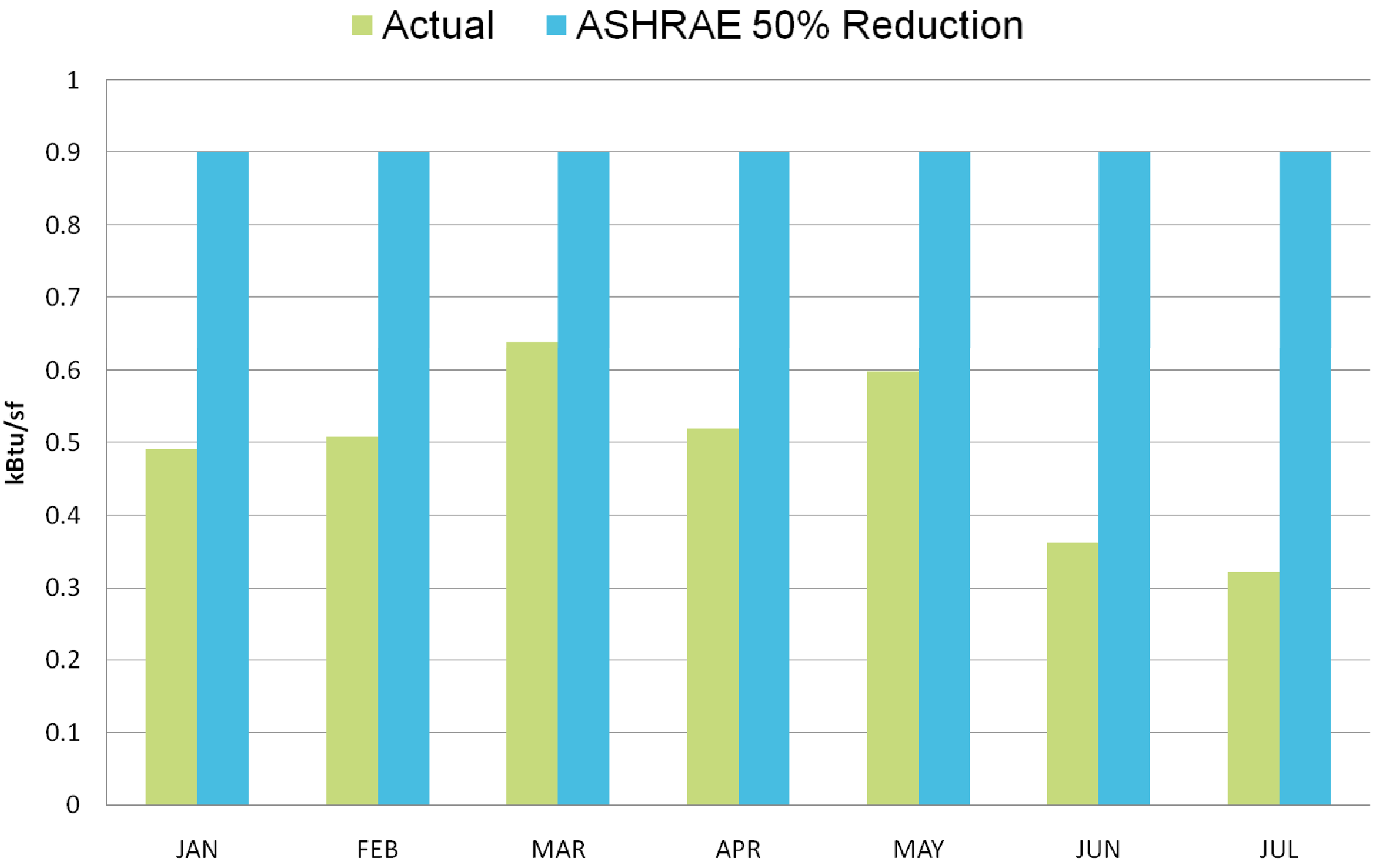
Kitchen – Energy



Behavior Changes - Computers

- TVA test case
- 7.5% of energy in “tested” school was consumed by computers
- Wireless technology throughout
- Laptop carts in lieu of computer labs
- Equipment off at night
- Reduces power consumption by 50%

Plug/Process Loads 2011



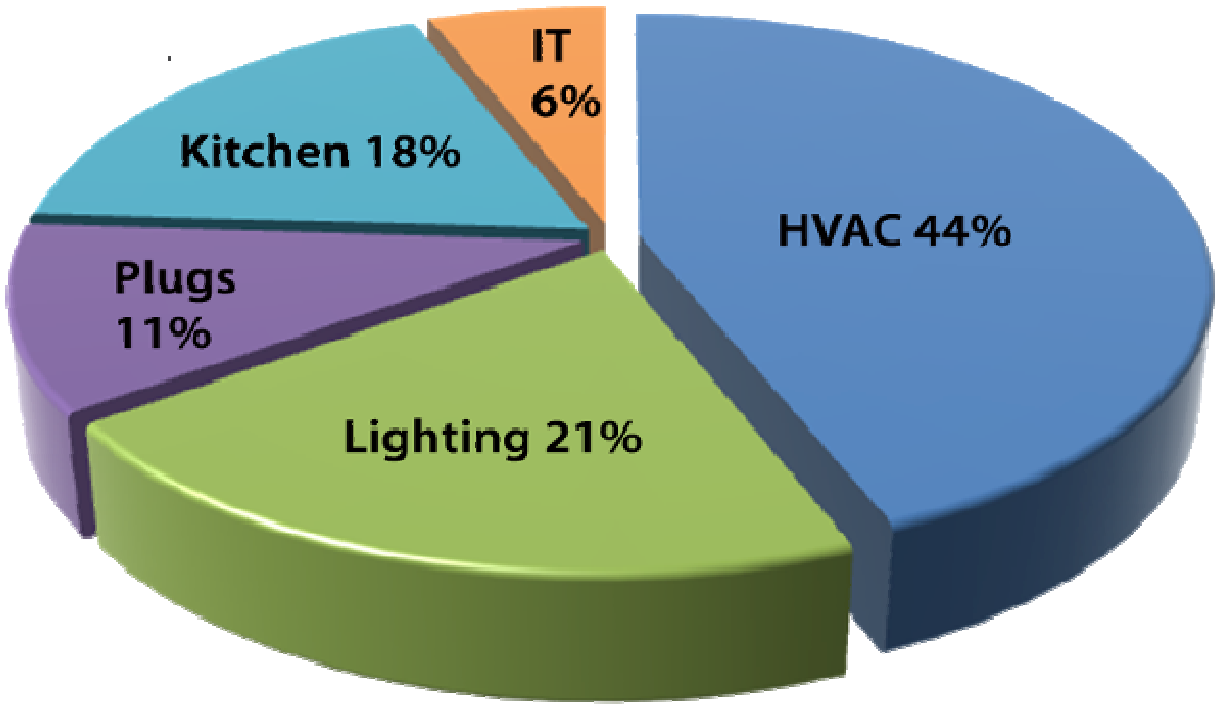
State Agency Support

- Remove obstacles and risks
- Allowed exceptions to building standards (ex. Kitchen, IT, HVAC)
- Changed classroom lighting standard
- Changed space programming requirements

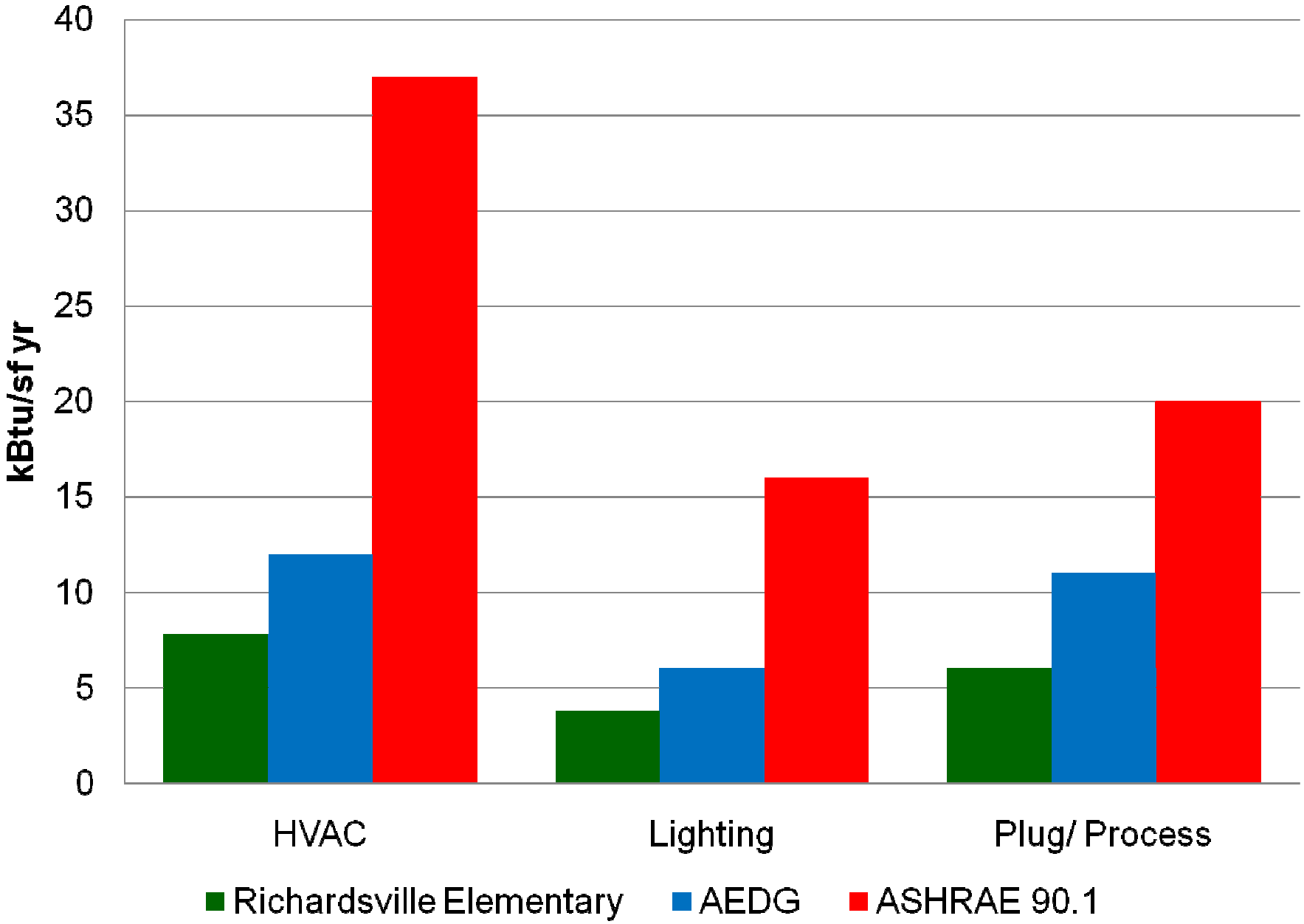
Behavior Changes - Lighting

- Dark sky approach
- Local police collaboration
- Façade lighting controls
- Eliminate building night lighting

Results
Richardsville: Energy Usage



Actual: 17.6 kBtu/sf yr


40
35
30
25
20
15
10
5
0
kBtu/sf yr
HVAC
Lighting
Plug/ Process
Richardsville Elementary
AEDG
ASHRAE 90.1

Solar Photovoltaic System

- 208 kW thin film – operational February 2011
- 138 kW crystalline – operational December 2011
- 408 MWh/yr electric production
- $2,766,000 cost (bid January 2010 @ $7.93/kW)

Electric Utility Summary

Read Date	Days of Service	Amount Due	Energy Cost	Demand Cost	Total Cost	Generation Credit
12/14/11	29	($622)	$2,612	$1,595	$4,207	($1.640)
11/17/11	29	($3,189)	$2,694	$1,440	$4,135	($2,618)
10/17/11	32	($4,705)	$2,915	$1,840	$4,755	($4,169)
9/15/11	30	($5,252)	$3,544	$2,274	$5,819	($5,215)
8/16/11	29	($5,857)	$3,162	$2,301	$5,464	($6,728)
7/18/11	32	($4,592)	$2,355	$1,274	$3,629	($6,665)
6/16/11	30	($1,555)	$2,846	$1,953	$4,799	($6,288)
5/17/11	32	($66)	$2,887	$1,788	$4,675	($4,440)
4/15/11	30	($301)	$2,427	$1,511	$3,938	($4,239)
3/16/11	30	$2,376	$2,755	$2,153	$4,908	($2,532)
2/14/11	31	$4,102	$2,766	$2,721	$5,487	($1,385)
1/14/11	30	$4,897	$2,475	$2,422	$4,897	$0

No utility payment for 9 months!

Net Zero Energy MWh Summary –

	MWh Consumed	MWh Generated (Predicted)	MWh Difference
December 11	29.2	15	14.2
November 11	31.8	20	11.8
October-11	30.4	32	(1.6)
September-11	38.1	41	(2.9)
August-11	28.0	48	(20.0)
July-11	28.4	54	(25.6)
June-11	28.1	51	(22.9)
May-11	34.1	45	(10.9)
April-11	27.7	38	(10.3)
March-11	33.8	31	2.8
February-11	30.0	18	12
January-11	34.3	12	22.3
	374	408	(33.0)

Richardsville Elementary Financial Model

Year	Annual Energy Cost 65 kBtu School	Richardsville 17 kBtu Energy Cost	Richardsville PV Revenue	Annual Savings
1	$109,039.00	$46,080.00	$84,183.00	$147,142.00
2	$112,310.00	$47,462.00	$86,708.00	$151,556.00
3	$115,679.00	$48,886.00	$89,310.00	$156,103.00
4	$119,150.00	$50,353.00	$91,989.00	$160,786.00
5	$122,724.00	$51,863.00	$94,749.00	$165,610.00
6	$126,406.00	$53,419.00	$97,591.00	$170,578.00
7	$130,198.00	$55,022.00	$100,519.00	$175,695.00
8	$134,104.00	$56,673.00	$103,534.00	$180,965.00
9	$137,127.00	$58,373.00	$106,641.00	$185,395.00
10	$142,271.00	$60,124.00	$109,840.00	$191,987.00
11	$146,539.00	$61,928.00	$113,135.00	$197,746.00
12	$150,935.00	$63,785.00	$116,529.00	$203,679.00
13	$155,464.00	$65,699.00	$120,025.00	$209,790.00
14	$160,127.00	$67,670.00	$123,626.00	$216,083.00
15	$164,931.00	$69,700.00	$127,334.00	$222,565.00
	$2,027,004.00	$857,037.00	$1,565,713.00	$2,735,680.00

New Children's Medical Center

- 100% Geothermal
- ICF exterior walls
- Efficient Lighting systems
- 120 kBtu/sf yr

New Corporate Office

- 100% Geothermal
- ICF exterior walls
- Daylighting
- PV system (15% of energy use)
- 18 kBtu/sf yr